International Core Journal of Engineering Volume 8 Issue 1, 2022
ISSN: 2414-1895 DOI: 10.6919/ICJE.202201_8(1).0082

Study on the Stability of Middle and Low Pressure Bearing Housing of Steam Turbine

Kaikai Dou

Huadian Longkou Power Generation Co., Ltd, Longkou, Shandong, 265700, China

Abstract

This paper briefly expounds the importance of the stability of medium and low pressure bearing box to the normal operation of steam turbine, analyzes the stability and strength of medium and low pressure box, puts forward the factors affecting the stability of medium and low pressure bearing box and some measures to increase the stability of bearing box, so as to provide solutions to the problems of bearing box in the future.

Keywords

Turbine, LP Beraring Box, Stability.

1. Introduction

While machines and equipment are running, safety comes first. (Peng Guowei) the absolute dead center of the unit shall be set in the body structure of large steam turbine, and usually the absolute dead center is located in the middle and low pressure bearing box of the steam turbine. If there is movement and poor stability in the design of the absolute dead center of the unit, the box will tilt forward or backward along the axial direction when the unit is started and shut down, resulting in the change of the central elevation of the unit, resulting in the increase of vibration, dynamic and static friction and other accidents of the unit. The medium and low pressure bearing housing is the core supporting component of the unit, and its manufacturing quality directly affects the installation and operation of the unit [1-3]. The oil film stiffness and bearing support stiffness shall be considered in the bearing design of the steam turbine unit [4]. The support stiffness mainly includes the bearing support stiffness and the support stiffness of the supporting part (bearing housing or cylinder), and the bearing support stiffness has a great impact on the stability, stability and stability of the unit Security is very important. [5]. In recent years, there are relatively few research reports on the stability of medium and low pressure bearing housing. Therefore, this paper expounds the importance of the stability of medium and low pressure bearing housing to the normal operation of steam turbine.

2. Brief Description of Bearing Support Structure of Large Steam Turbine Unit

The sliding bearing used in steam turbine unit has complex structure, including tilting pad bearing, three oil wedge bearing, elliptical bearing, etc. From the structure of the support part, it is mainly divided into bearing box support and cylinder support, that is, floor bearing and non floor bearing. In the early stage, the bearings of steam turbine units were mostly non landing type due to the small power of single unit. With the increase of power demand and the requirements of efficiency and environmental protection [6-9], the single unit capacity is increasing, and the volume of steam turbine unit is becoming larger and larger, especially the low-voltage module is becoming larger and larger. The bearing landing technology is adopted for nuclear motor units, which improves the stability and operation safety of shafting. In the design of steam turbine, due to the limitations of unit cost, unit plant, rotor materials, processing and forging equipment and other factors, the design of the whole unit shall not be too long, and the span of the unit shall not be too large. In order to reduce the production cost and ensure the boundary conditions such as steam turbine output, it is required to

ISSN: 2414-1895 DOI: 10.6919/ICJE.202201_8(1).0082

compress the flow passage stages of the whole unit within the possible range, increase the average diameter of steam passage of moving and stationary blades, and increase the enthalpy drop at each stage of flow passage. However, this scheme is limited by centrifugal force factors such as blade material and structure; Another alternative is the length of the non flow part of the compressor unit, that is, the axial length of the compression bearing housing. This limits the design of the bearing housing and has to design the shape of narrow axial and long transverse. If the narrow and long structure is used as the dead center of the intermediate bearing box, the stability of the box is bound to be poor.

3. General Introduction of Medium and Low Pressure Bearing Housing

The medium and low pressure bearing box is composed of the upper half thrust bearing cover, the front box cover, the rear box cover and the lower half box. The medium and low pressure bearing housing has five internal holes, oil seal gears at both ends and bearing gears in the middle. The middle and low pressure bearing gears are semicircular structure, and the other three gears are full circle [10]. The intermediate pressure bearing gear and thrust bearing gear support the high and intermediate pressure bearing and the high and intermediate pressure rotor, the low pressure bearing gear supports the low pressure bearing and the low pressure rotor, and the cat claw at the intermediate pressure exhaust end of the high and intermediate pressure cylinder is pressed on the support surface of the box.

4. Design Difficulties of Stability of Medium and Low Pressure Bearing Housing

In the design of steam turbine, due to the limitations of unit cost, unit plant, rotor materials, processing and forging equipment and other factors, the design of the whole unit shall not be too long [11], and the span of the unit shall not be too large. In order to reduce the production cost and ensure the boundary conditions such as steam turbine output, it is required to compress the flow passage stages of the whole unit within the possible range, increase the average diameter of steam passage of moving and stationary blades, and increase the enthalpy drop at each stage of flow passage. However, this scheme is limited by centrifugal force factors such as blade material and structure; Another alternative is the length of the non flow part of the compressor unit, that is, the axial length of the compression bearing housing. This limits the design of the bearing housing and has to design the shape of narrow axial and long transverse. If the narrow and long structure is used as the dead center of the intermediate bearing box, the stability of the box is bound to be poor. The deformation of axial positioning surface of bearing housing, cat claw support surface and support bearing position has a certain impact on the flow clearance. Therefore, when designing the medium and low pressure bearing box, we should not only consider the rigidity of the bearing box, but also consider its stability, so as to ensure the safe and reliable operation of the unit. The machining allowance on one side of medium and low pressure bearing housing is 10 ~ 20 mm. Due to blank error, the maximum machining allowance is about 25 mm. In order to reduce the machining error caused by machining stress, stress relief heat treatment process is carried out after rough machining, and then finish machining. During rough machining, 30 mm machining allowance shall be reserved on both ends of medium and low pressure bearing gear for tool setting and hole diameter measurement during fine boring, and 4 mm machining allowance shall be reserved on one side of other parts before finishing. During processing, the clamping and support mode of the workpiece shall be consistent with or close to the general assembly and power plant installation mode as far as possible, and the load distribution shall be increased on the split surface and bottom surface in the processing, so as to reduce the influence of the deflection deformation, distortion deformation, gravity deformation and other factors of the workpiece on the processing accuracy. The bottom surface is required to be in contact with the spherical pad iron, and the bottom surface needs to be used as the process benchmark of other processing parts during processing, so finish machining first. The traditional method of bottom machining is: bottom face up, directly in the gantry milling. The biggest problem of this method is

ISSN: 2414-1895 DOI: 10.6919/ICJE.202201_8(1).0082

that the position of the fulcrum is inconvenient to select, the supporting force of each fulcrum is inconvenient to determine, and the deflection deformation caused by gravity is inconvenient to eliminate. For the workpiece with simple structure, the deflection can be obtained through theoretical calculation to determine the jacking amount and select the fulcrum. The box has complex structure, difficult theoretical calculation, large error and high labor input cost. For vertical placement of the bottom surface, first use the boring machine to process the leveling datum and support datum of the gantry milling flat placement station, and then use the gantry milling to support and level the bottom surface according to these datum, which can well ensure the processing accuracy of the bottom surface and completely solve the problems such as difficult selection of fulcrum and inconvenient elimination of deflection deformation.

5. Instability Factors of Bearing Housing

The main factors causing the instability of medium and low pressure bearing housing are the axial force acting on the push-pull device and the push-pull height. The magnitude of the force is related to the following factors: (1) The installation level of the unit, i.e. whether the clearance of the sliding pin system is guaranteed, whether each sliding surface is flat and smooth, whether the contact surface is required to be qualified, whether the high-temperature lubricant used on the sliding block plays a role in lubrication, whether the central installation of cylinder, rotor and bearing is consistent, and whether the temperature difference between the left and right of cylinder flange during operation is within the allowable range of operation regulations. (2) The layout and installation method of the pipeline, whether the cold drawing technology and flexible expansion joint are adopted. (3) the weight of the unit body and the weight of thermal insulation materials. The rotor is an important component of the machine and has a great impact on the operation of the machine. Figure 1 shows the internal structure of the rotor. When the installation capacity of the machine is expanded and the rotor is thermally deformed, abnormal vibration of the machine will be caused. On the one hand, based on the analysis of the vibration characteristics of the rotor thermal deformer, it is found that the vibration amplitude is related to the working time of the rotor. If the rotor runs for a long time, it will emit a lot of heat and make the temperature rise sharply. Machine overload will seriously affect the turbine cooling system and change the metal properties of the rotor itself. When the machine is running at a given speed, most turbine rotors will be thermally deformed. On the other hand, the rotor will deform after continuous heating [12]. The "dent" machine will get stuck in the working channel, causing abnormal vibration. The internal stress will change obviously according to the different materials and heat dissipation. When the rotor is heated, it will not only gradually increase multiple vibration, but also lead to material phase transformation due to heat diffusion frequency, aggravating the abnormal vibration of the rotor.

6. Conclusion

In the design of medium and low pressure bearing housing, in addition to the above stability analysis, it is also necessary to check the strength of pressing plate and pressing plate bolts, bolt threads and base frame threads, as well as the rigidity of the box. Control the magnitude of the above axial force as much as possible, At the same time, the following measures shall be taken: (1) under the condition of meeting other design conditions, the axial length of medium and low pressure bearing box shall be increased as much as possible and the stabilizing force arm shall be increased, so that the stability of bearing box can be effectively increased even if the number and stress of pressing plate remain unchanged. (2) Reduce the position of the action point of the push-pull device to make it as close to the bottom of the box as possible and reduce the overturning force arm, which is a main measure to increase the stability of the bearing box. (3) Increase the number of pressing plates, increase the distance between pressing plates, and make the pressing plates as close as possible to the front and rear ends of the bearing box. Improve the strength and tightening force of the pressing plate bolts, change the ordinary material bolts into high-strength alloy steel bolts, increase the thickness of the pressing plate pressing box, and position the pressing plate bolts as close as possible to the bearing

ISSN: 2414-1895 DOI: 10.6919/ICJE.202201_8(1).0082

box, so as to effectively increase the bearing capacity of the pressing plate. (4) If necessary, the low-pressure cylinder can be used to press the rear end of the medium and low-pressure bearing housing to prevent the inclination of the housing, and can also effectively increase the stability of the bearing housing.

References

[1] Xie Longfei Improvement of processing technology of medium and low pressure bearing housing of nuclear power turbine [J] China heavy equipment, 2021 (04): 58-61 DOI:10.14145/j.cnki. 51-1702/th. 2021.04. nineteen

[2] Qi Hongtao Cause analysis and treatment of high vibration value of steam turbine bearing [J] Chemical management, 2021 (29): 148-149 DOI:10.19900/j.cnki. ISSN1008-4800.2021. 29.071.

[3] Jiang Jun, Xiao Chengming Treatment of small turbine lubricating oil particle size slightly exceeding the standard of 600MW Unit [C] / / Proceedings of the annual meeting of Jiangxi Institute of electrical engineering in 2020, 2021:111-113. DOI:10.26914/c.cnkihy. 2021.000190.

[4] Zeng Shengli, Yang Yanli, Liu Li Cause analysis and treatment of flash explosion of steam turbine front bearing box [J] Petroleum technician, 2020 (03): 65-67.

[5] Guo Kang Discussion on typical cases of steam turbine bearing self positioning [J] Internal combustion engines and accessories, 2020 (08): 79-81 DOI:10.19475/j.cnki. issn1674-957x. 2020.08. thirty-six.

[6] Xu Guolin, Liu Yang, Zhao Yingying, Wang Jian, Yu Haipeng Analysis on structural characteristics of high efficiency 80mW subcritical condensing steam turbine [J] Steam turbine technology, 2020,62 (02): 93-95 + 98.

[7] Feng Kun, Liu Yaqiong, Chen Baoxing, Zhu Yiming. Test method and experimental study on bearing load distribution of 1000 MW steam turbine [J] Thermal power engineering, 2019,34 (04): 55-59 DOI: 10.161 46/j.cnki. rndlgc. 2019.04. eight.

[8] Voltaic forest Cause analysis and treatment measures for wear of steam turbine bearing and rotor parts [J] Chemical engineering and equipment, 2019 (04): 232-234 DOI:10.19566/j.cnki. cn35-1285/tq. 2019.04. ninety-nine.

[9] Yin Huajie, Yin Gang, Wu Fangsong, Zhao Jin, Wang xingzhao Study on lifting mode of million full capacity feed pump turbine [J] Dongfang turbine, 2019 (01): 35-38 DOI:10.13808/j.cnki. issn1674-9987. 2019. 01.009.

[10] Ma Li, Yang Ziling, Li Qiang Cause analysis of turbine thrust disc tear of super large air compressor unit [J] Guangzhou chemical industry, 2019,47 (04): 116-118.

[11] Zhang Haifeng, Lin Maosheng, Duan Haizhou, pan Junsheng Adjustment of turbine bearing lubricating oil flow [J] Equipment management and maintenance, 2021 (11): 159-160 DOI:10.16621/j.cnki. issn1001-0599.2021. 06.72.

[12] Qiu ronghua Design of turbine lubricating oil pump control system based on PLC [J] Nanfang agricultural machinery, 2021,52 (09): 122-124.